Precipitation In Extratropical Cyclones: observational uncertainties

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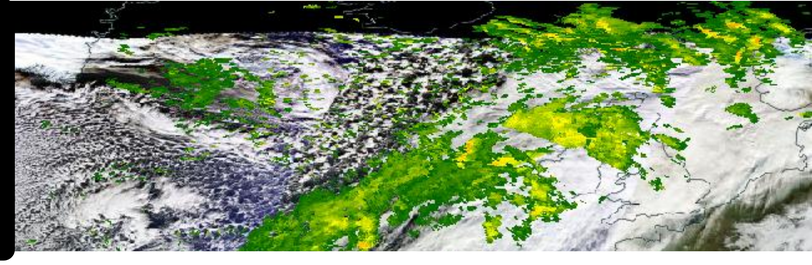


INTRODUCTION

Extratropical cyclones (ETC) = important source of precipitation in mid-latitudes but no consensus on evolution in a warming climate, i.e. more or less precipitation? Most GCMs predict rain too frequently with rates when occurring that are too small. Problem found also within ETCs.

=> Need observational constraint to help pinpoint processes that need improvement in GCMs

Here: Created GPM-ETC database = GPM precipitation retrievals associated with ETCs with both CMB and IMERG: https://data.giss.nasa.gov/storms/obs-ETC

⇒ Use database to composite midlatitude precipitation in Extratropical Cyclones from different datasets to provide detailed uncertainties for model evaluation

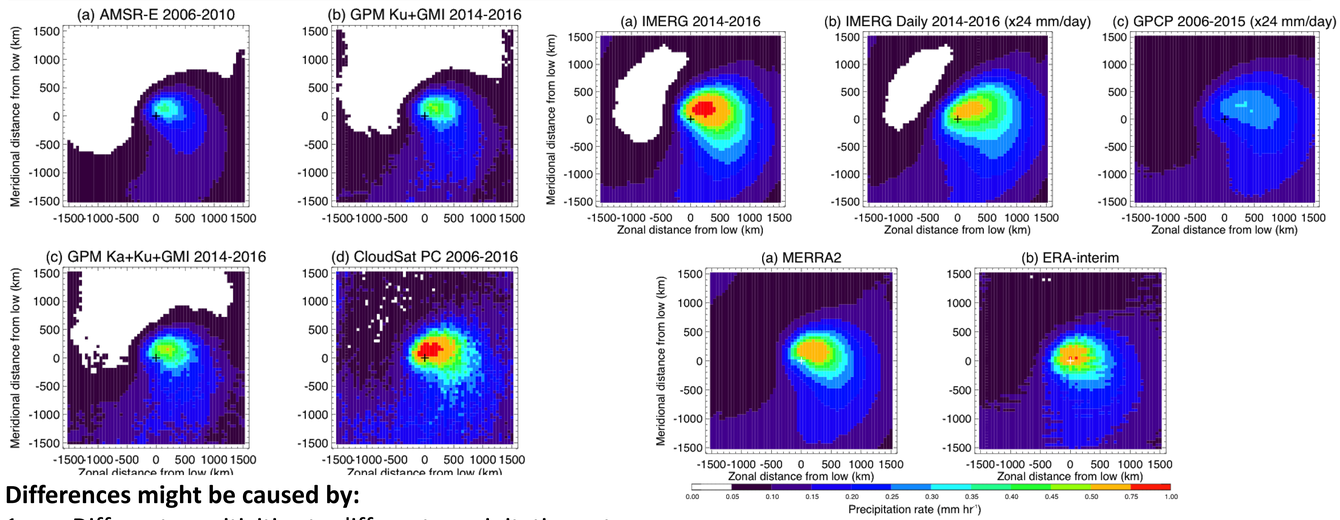
Datasets:

- GPM-CMB version 5: Ku+GMI and Ka+Ku+GMI
- CloudSat R04 2C-PRECIP-COLUMN
- GPM IMERG version 4
- AMSR-E V10
- GPCP-1DD V 2.1
- MERRA-2 & ERA-interim

Method:

- Use identical cyclone-centered rectangular grid of 50 km resolution and dimensions ± 1500 km
- Project precipitation rate retrievals (including zero precip.) into grid
- Average all cyclones with data using center as anchor when center within 30-60°N/S over the ocean

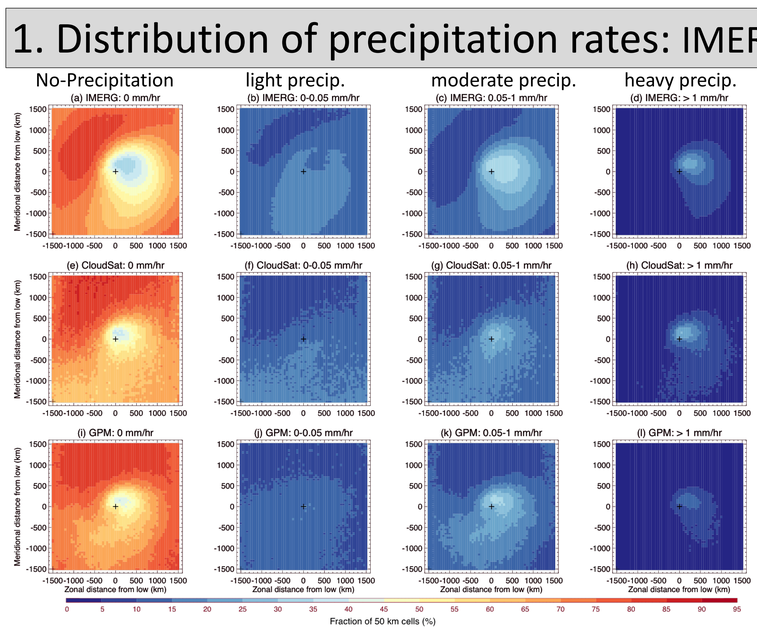
Cyclone-centered composites of precipitation



Differences might be caused by:

1. Different sensitivities to different precipitation rates
2. Different sampling of cyclone age, latitude band, month, period of observations & coverage of cyclone area

1. Distribution of precipitation rates: IMERG, CloudSat, GPM-CMB

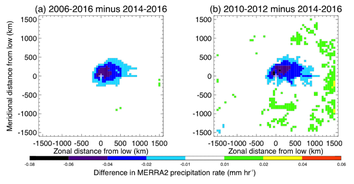


IMERG, CloudSat & GPM-CMB Ka+Ku+GMI

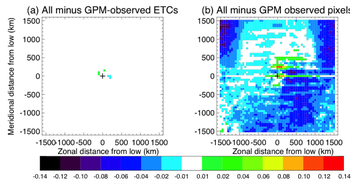
- IMERG detects precipitation more often than CloudSat and GPM-CMB
- GPM-CMB shows lower sensitivity to light precipitation
- CloudSat shows lower sensitivity to moderate precipitation (attenuation) but larger to light precipitation

2. Impact of cyclone distribution/sampling

MERRA-2 2014-2016 vs. 2006-2016 & 2010-2012

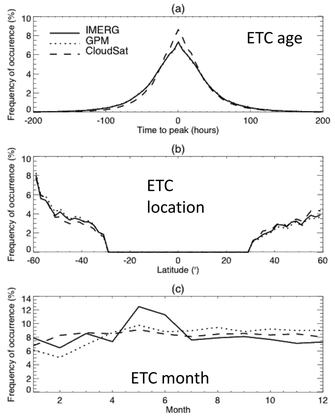


MERRA-2 sampled along GPM orbit

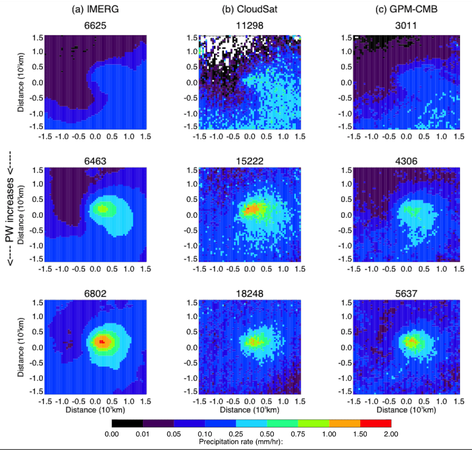


Interannual variability: impact < 0.06 mm/hr – Sampling: larger impact up to 0.14 mm/hr

Freq. Occ. ETCs as a function of age, latitude and month => largest difference is monthly representation but little impact on composites



3. Impact of cyclone-wide PW



Cyclone-centered composite of precipitation as a function of cyclone-wide mean PW

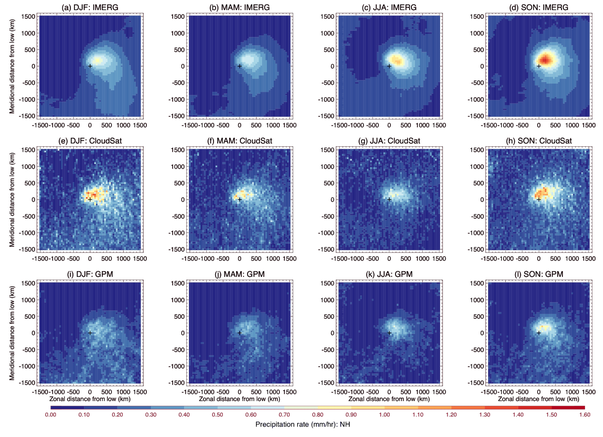
Left: IMERG Middle: CloudSat Right: GPM-CMB Ka+Ku+GMI

Dry ETCs (top row): more precipitation at center and warm sector with CloudSat, less in west-poleward quadrant

Moderate PW ETCs (middle row): CloudSat > IMERG/CMB everywhere

Large PW ETCs (bottom row): IMERG > CloudSat/CMB at center and equatorward

4. NH seasonal variations



NH composites for IMERG (top), CloudSat (middle row), GPM-CMB Ka+Ku+GMI (bottom row)

Similar seasonal variations with three datasets

CloudSat reports greater rates in DJF/MAM than IMERG/CMB but smaller than IMERG in JJA/SON

GPM-CMB reports systematically less precipitation than other two

Ref: Naud C.M., J. F. Booth, M. Lebsock and M. Grecu, 2017, submitted to JAMC.